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Application of NI Real-Time Hypervisor in Bellows Swing Measurement and Control System

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Abstract

Bellows is cylindrical thin-walled shell which has a reliable compactable structure. It is often used as a tie between engines and fuel tank.This measurement and control system can simulate the real status of the bellows in the space. The bellows which contains liquid substances can also be sway in a high frequency. The system is made by NI Real-Time Hypervisor, LabVIEW under the windows operating system. It is a real-time system whose control period is only 1ms.The hardware is simple too, one computer with dual-core processor and one signal conditioner chassis.

Key words: LabVIEW,Real-Time Hypervisor,Measurement and Control System;

1. Introduction

LabVIEW is a graphical programming language developed by NI of United States, which simplifies the development process, allowing engineers to quickly set up monitor and control software platform, is widely used in measurement, process control, industrial automation and other fields. LabVIEW RT can only be run in real-time hardware system, which gives engineers many difficulties in developing LabVIEW Real-Time programs with Windows operating system (multi-tasking, non-real-time operating system).NI Real-Time Hypervisor, which makes use of the virtualization technology, can run NI LabVIEW Real-Time programs and Windows XP on multi-core PXI system and industrial controllers parallel, provide users a stabile test, measurement and control application platform, and cuts hardware cost and the physical package

Bellows swing test system is a method of studying the bellows mechanical properties, strength and life, which can simulate the extrusion and torsion process of bellows with long-term power in short time through fast swing to extrude fluid-filled bellows. In this paper, we develop the bellows swing test system in use of NI's Real Time Hypervisor. The hardware platform is built by NI PXI-1031 NI PXI-8108,NI PXI-6259, and the software is LabView and LabVIEW RT in Windows. The system, which has simple

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structure, short development cycle, real-time performance, and good running condition, and achieves real-time acquisition, real-time control and rapid development purposes.

2. Introduction to swing test system

The swing control console is the “brain” of the entire bellows swing test system, it is in charge of a series of tasks, such as data acquisition, process control, status monitoring and so on, so it needs to interact with various parts of the system, for example, regulate the pressure by controlling the speed of the hydraulic pump, water bellows and drainage by controlling the pump, achieve position control by controlling current size of the hydraulic valve based on the feedback of LVDT ,and so on, System structure is shown in Fig 1.

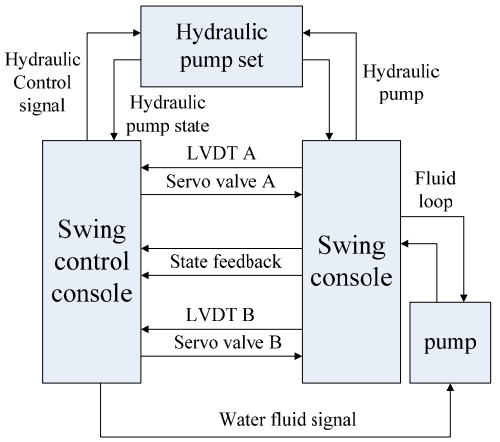

Fig. 1 Bellows swing test system

Bellows swing test system is a typical dual-channel real-time hydraulic control system. It needs the swing control console to control the two hydraulic cylinders to achieve higher precision real-time position attitude control of swing console and optimize trajectory to prevent internal stress generated by uncoordinated movement damaging the system.

3. Structure of swing control console

The working frequency of swing console, which works with a huge load, required by bellows swing test system exceeds 100 beats/min, so the required control period of swing test system is millisecond.

The hardware of the system uses NI PXI-1031 chassis, PXI-8108 embedded controller and PXI-6259 multifunction data acquisition card. The operating system platform is Windows+Real-Time hypervisor, the software development platform is LabView and LabView RT.

In this system, the control console uses PXI-6259 to acquire data and uses voltage-controlled current source to control hydraulic valves to achieve the position and attitude control. The electrical isolation and signal conditioning between console and other devices is carried out by signal conditioning chassis. In addition, some of key data will be displayed and monitored in digital meter though 485 serial port.

The operating system, Windows+Real-Time Hypervisor, is separated into windows operating system and LabView real time system by Real-Time Hypervisor, and the time resolution of LabView real time system can be up to microsecond. The I/O devices and RAM between operating systems are divided by internal program manager of Real-Time Hypervisor, and then the real time data acquisition and regulation

is carried out. At the same time, LabVIEW Real-Time program uses virtual network exchanging data with software operating platform in Windows.

4. software procedure and implementation

The program runs separately as two sub-systems, they are LabVIEW program in Windows OS and real time data acquisition and movement control program running in LabVIEW real time OS. The two sub-systems exchange data though virtual network.

4.1. workflow of user interface

The LabVIEW subroutine in Windows OS is used to perform user's interface and interactive with users. After the initialization of LabView and LabView RT system, enter into the swing experiment operating interface. Firstly, load the product. Secondly, user sets test parameters, then, the interface passes swing trajectory data to LabView RT program though virtual network. Press the 'begin' button, carry out swing experiment. During the experiment, users can run, pause, and stop the experiment. At the same time, LabView passes the data collected by PXI-6259 to user program, which can display and save data, though virtual network. Program flow diagram shown in Figure 2

4.2. LabView RT workflow

LabVIEW RT system uses to run real-time LabView programs in real-time data acquisition and PID control. After running, initialize hardware device firstly, then wait for trajectory and instruction data. After the beginning of swing experiment, the program controls servo valve to achieve position control though integral separation PID control algorithm with dead-band. At the same time, program passes the data acquired to user interface for simultaneous display through virtual network.

4.3. TCP/IP network communication

Between the user program with LabVIEW RT Real-Time Hypervisor built by, the programming mode and LabVIEW programming consistent network communications, The Virtual network communication between user program and LabVIEW RT is built by Real-Time Hypervisor, its programming mode is the same as LabVIEW programming of network communication. LabVIEW network communication support multiple communication modes, the simplest way to achieve it is sharing variable though network. Because of large amount of network transmission, the system uses TCP/IP protocol to transmit data.

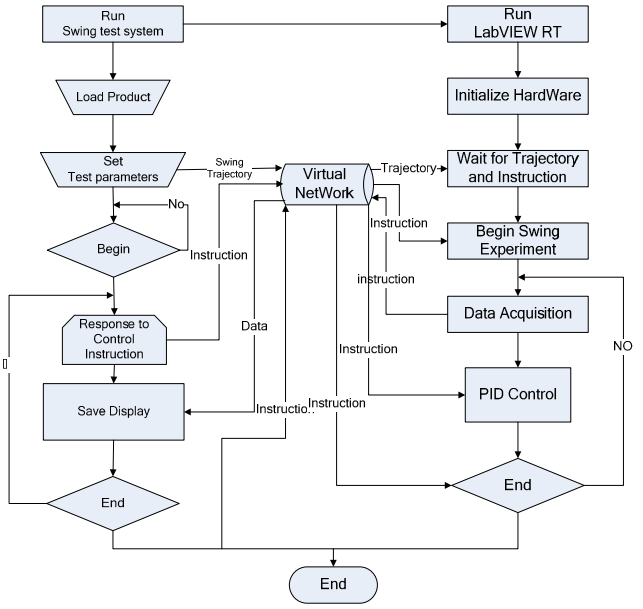

Fig2 Swing test system software flow chart

5. Application results

The timing period of LabVIEW RT in real system is 1ms, and there are no exceptions, no significant vibration phenomenon in the whole control process. The actual running status matches with the Meter data, the step response of system is not more than 5 %, and the real-time performance is good.

6. Conclusion

The real-time control and data acquisition of bellows swing test system and the swing trajectory and attitude control of high-power dual-channel hydraulic system are achieved by program implemented above, the control problem of complex strength test of bellows is resolved successfully. The features of the system are: LabView development platform is compatible with Real-Time Hypervisor , so fast software development is easy; The system is simple, a dual-core computer + data acquisition card can achieve real-time control and display.

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